For Mr Sykes

VOLUME XXIII NUMBER 8 WHOLE NUMBER 187

THE JOURNAL

OCT 18 1929

OF

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

DEVOTED TO THE ADVANCEMENT OF ASTRONOMY AND ALLIED SCIENCES

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THE JOURNAL

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VOL. XXIII, No. 8 OCTOBER, 1929 WHOLE No. 187

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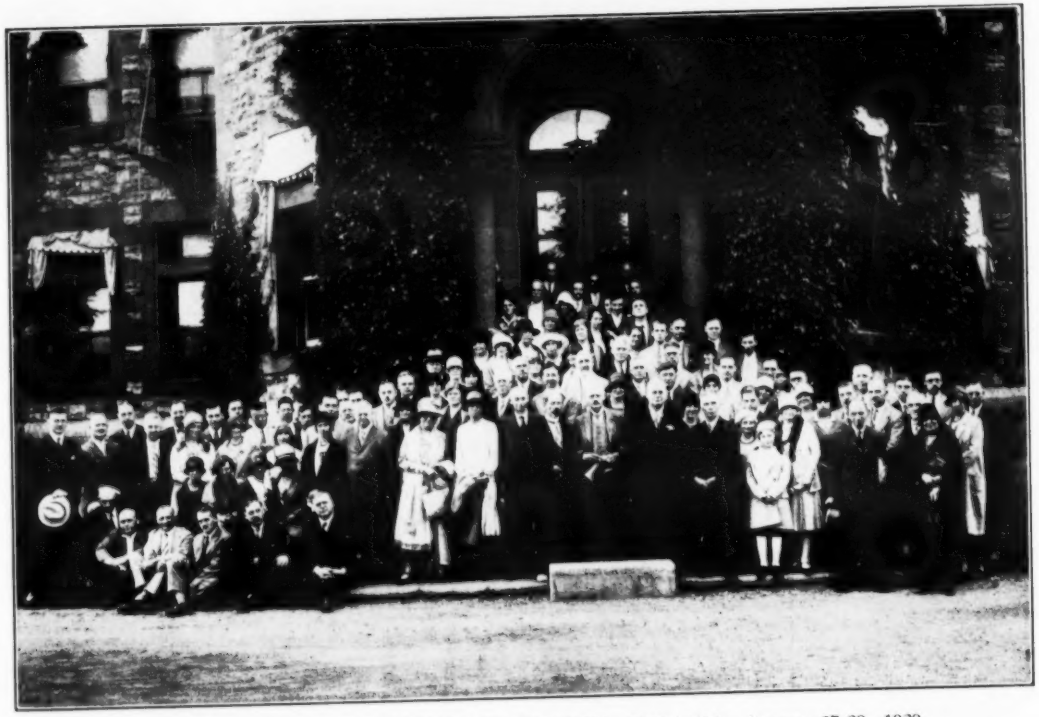
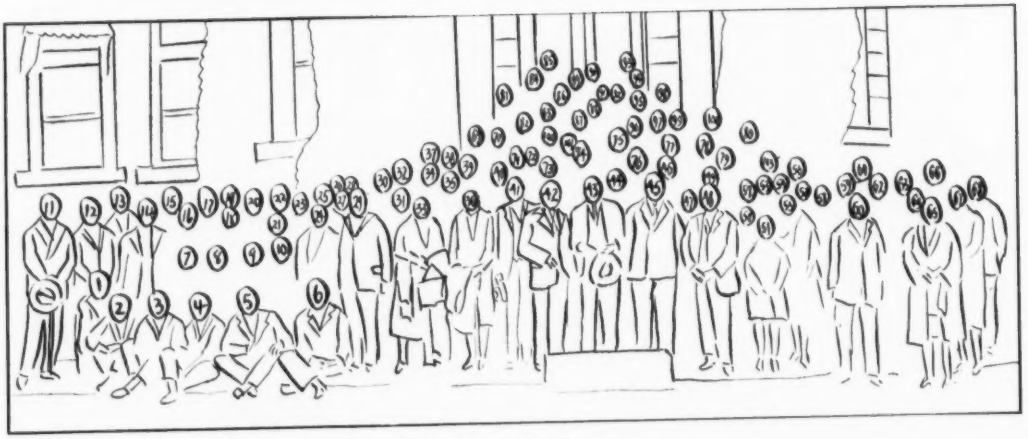


THE AMERICAN ASTRONOMICAL SOCIETY, OTTAWA, August 27-29, 1929.



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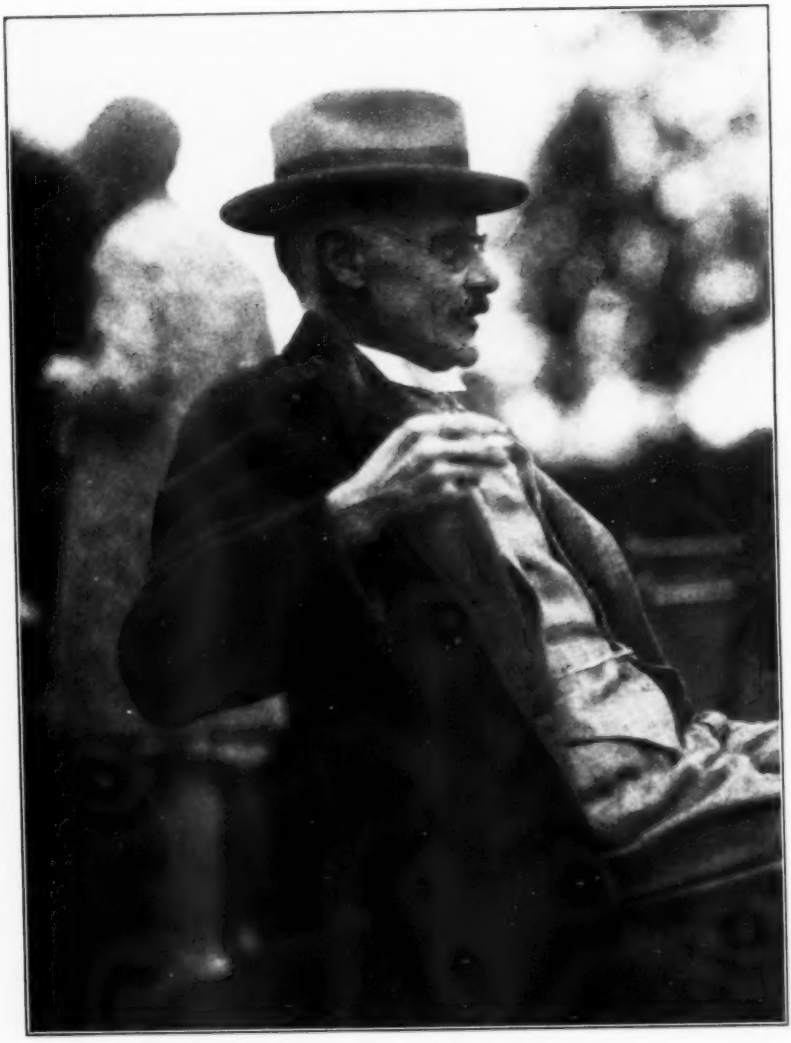
1. Smith
2. De Lury
3. Albrecht
4. Sills
5. Pearce
6. Hamer
7. Miss Allen
8. Miss Albrecht
9. Mrs. Henroteau
10. Miss Glancy
11. Henroteau
12. Fecker
13. Stokley
14. Nugent
15. Dolan
16. Mrs. Albrecht
17. Hawkins, R. H.
18. Miss MacDonald
19. Henderson
20. McClenahan
21. Miss Nevins
22. Littell, C.
23. Helwig
24. Miss Losh
25. King
26. Morgan, H. R.
27. Littell, F. B.
28. Kenny
29. Peters
30. Van Arnam
31. Mrs. Losh
32. O'Connor
33. Miss Furness
34. Mrs. Fecker
35. Mrs. McLaughlin
36. Miss Harwood
37. Kingston
38. Mrs. Kingston
39. Miss Seydel
40. Jordan, F. C.
41. Dugan
42. Stewart
43. Brown
44. Mrs. Kovalenko
45. Ogilvie
46. Kovalenko
47. Miss Young
48. Chant
49. Mrs. Fairley
50. Miss Dugan
51. Miss McDiarmid
52. Fairley
53. Mrs. Dugan
54. Mrs. Burton
55. Mrs. McDiarmid
56. Mrs. Merrill
57. Mrs. Merrill
58. Mrs. Dietz
59. Dietz
60. Hawkins, A. W.
61. Hammond
62. McDiarmid
63. Watts
64. Dier
65. Mrs. Hammond
66. Balmer
67. Mrs. Watts
68. Doxsee
69. Mrs. Jordan
70. Mrs. Stewart
71. Curtiss
72. Mrs. Littell
73. Arnold
74. Milham
75. Fisher
76. Lane
77. Eckert
78. Miss Lamson
79. Justin
80. Elvey
81. Seb. Albrecht
82. Miss Douglas
83. Miss Barney
84. Pawling
85. Miller
86. Miss Krampe
87. Miss Cummings
88. Miss Gilman
89. McLaughlin
90. Jordan, M. F.
91. Miss Turner
92. Miss Burland
93. French
94. Lewis, R.
95. Westland
96. Mrs. Chant
97. Morgan, W. W.
98. Mrs. Lewis
99. Young
100. Struve
101. Mrs. Thomson
102. Miss Douglas
103. Burton

PLATE XXIII



ERNEST WILLIAM BROWN,
President, American Astronomical Society.

PLATE XXIV

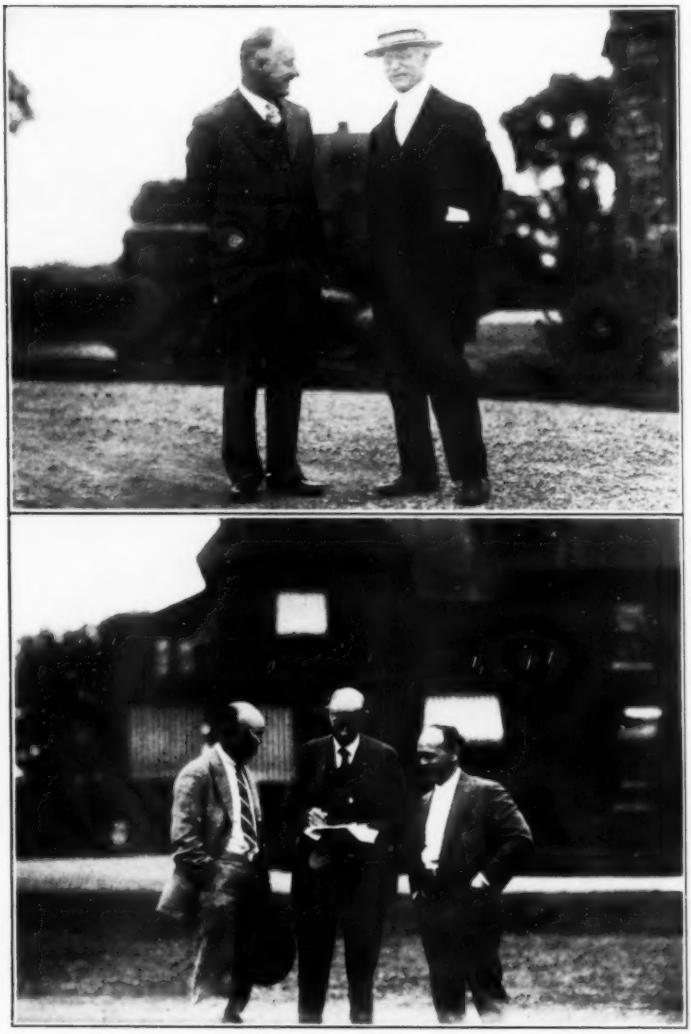
Above. Ann Arborites: Henroteau, Miss Seydel, Albrecht, Mrs. McLaughlin, Curtiss, Mrs. Losh, Balmer, Miss Losh, McLaughlin.
Below. Tortontonenses: Smith, Arbogast, Kenny, Hawkins, Mrs. Chant, Chant, Balmer, Mrs. Stewart, Henderson, Miss Cummings, Nugent, Stewart, De Lury, McDiarmid, Grant.

PLATE XXV

Above. McDiarmid, Dugan, Mrs. Kovalenko, Mrs. Merrill, Priscilla Dugan, Miss Young, Mrs. Dugan, Kovalenko, Merrill, of the Princeton persuasion.
Below. U.S. Naval Observatory stalwarts: Pawling, Littell, Peters.

Journal of the Royal Astronomical Society of Canada. 1929

PLATE XXVI



Above. Fecker and Littell discuss the possibilities of a 300-inch reflector.
Below. Dugan tells a couple of the "old boys" of the changes which have taken place at "dear old Princeton" since the time when their heads were covered.

PLATE XXVII

Above. Dr. Brown and Dr. Glashan stop, for a hundredth of a second, the discussion of the velocity of gravity.

Below. Mrs. Fecker, Mrs. Lewis, Miss Furness, Mrs. Jordan and Mrs. Albrecht examine the haunts of the birds.

THE JOURNAL
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VOL. XXIII, No. 8 OCTOBER, 1929 Whole No. 187

THE FORTY-SECOND MEETING OF THE AMERICAN ASTRONOMICAL SOCIETY

By Ralph E. De Lury

"The Assyrian came down like the wolf on the fold, And his cohorts were gleaming in purple and gold." No, in the words of the old song, "it was not like that at all." The Chief, far from resembling the wolfish Assyrian, is the gentlest of men, and his tribe one not noted for their purple and gold, albeit many of them came in chariots that shone "like the stars on the sea." The occupation of Ottawa by the American Astronomical Society was peaceful and pleasant, though carried out with the precision of a military movement. In the preceding months the highways and territory had been carefully reconnoitred, and the programme prepared. On Monday evening, August 26, the Council assembled at the Chateau Laurier to conclude their plans. Next morning at ten o'clock promptly the cohorts filled the lines prepared for them by their allies in the Dominion Observatory, and were silenced by a word from their chieftain in readiness to examine critically the impedimenta to be presently displayed in turn by the faithful.

In his introductory remarks, President E. W. Brown expressed the appreciation of the Society in being invited to meet in Ottawa, and he recalled the earlier meeting at the Observatory "a Saros ago", in 1911. Director R. Meldrum Stewart welcomed the Society to the Observatory and expressed the hope that they would meet again in Ottawa before another eighteen years elapsed. Secretary R. S. Dugan and Mr. Stewart made announcements concerning the

programme and entertainments. The arrangements were: Tuesday, sessions for papers morning and afternoon, then the group photograph, and in the evening a reception at the Observatory when the visitors were to have an opportunity of examining its various activities; Wednesday, session for papers in the morning, and a motor drive followed by tea on the lawn at the Observatory in the afternoon, and in the evening a lecture on "Engineering in Astronomy" by J. W. Fecker at the Victoria Memorial Museum; Thursday morning, a business session for the adoption of the new Constitution, election of Officers and Committees and presentation of the list of members elected (14), followed by a session for papers and another in the afternoon, and in the evening the farewell dinner at the Chateau Laurier; each day, luncheon at the Geodetic Survey Building adjacent to the Observatory, and for leisure moments, far too few, a welcome at the residences of the Director and Assistant-Director for a game of "bridge" or a view of the "fauna and flora."

During the sessions 45 papers were presented and 2 read by title. These may be conveniently listed in the following groups:

General Reports:—"Astronomy and the Canadian Government", R. Meldrum Stewart; "The Dominion Astrophysical Observatory and its work", J. S. Plaskett, read by Mr. J. A. Pearce; "The aims and policies of the Geodetic Survey of Canada", N. J. Ogilvie; "Seismology in Canada", E. A. Hodgson; "Canadian investigations in gravity", A. H. Miller; "Terrestrial magnetism in Canada", C. A. French; "Legal time in Canada", C. C. Smith.

Sun and Solar System:—"The maximum duration of a total solar eclipse", Mrs. Isabel M. Lewis; "The solar eclipse of May 9, 1929, as observed in Molaya", H. T. Stetson; "The recent sun-spot maximum, as deduced from mean monthly areas at U.S. Naval Observatory", G. H. Peters and N. E. Wagman; "The orbit of Jupiter's eighth satellite: completion of the first stage", E. W. Brown; "Sun-spots and tree growths in Canada", J. L. O'Connor and R. E. De Lury; "Some measurements of the solar rotation", C. R. Westland, J. L. O'Connor and R. E. De Lury; "The interpretation of the aurora spectrum", V. M. Slipher and L. A. Sommer.

Time and Positional Astronomy:—"A new method of determining

time", F. B. Littell and J. E. Willis; "A new method of driving a travelling-wire micrometer", C. B. Watts; "Zone corrections in right ascension from the Canadian longitude observations of 1926", R. J. McDiarmid; "Annual variations of underground azimuth marks", W. S. McClenahan; "Comparison of the vernier and automatic methods of wireless signal reception", J. P. Henderson.

Variable stars, orbits, binaries, velocities:—"Anomalous behaviours of cyanogen in three variable stars", Miss A. Vibert Douglas; "The galactic rotation and the K term for the O and B type stars", J. S. Plaskett and J. A. Pearce; "The motions of the interstellar calcium", J. S. Plaskett and J. A. Pearce; "Are all Cepheids long-period binaries?", F. Henroteau; "Extra-focal photometry at the Yerkes Observatory", A. S. Fairley; "A study of the spectrum and orbit of Upsilon Sagitarii", Miss Frances L. Seydel; "Note on the light and velocity curves of Epsilon Aurigae", D. B. McLaughlin; "Velocity studies of b^2 28 Cygni", Miss Hazel M. Losh; "A note on the emission lines in the Beta Lyrae spectrum", Mrs. D. B. McLaughlin; "Periods of class Be spectrum variables", R. H. Curtiss; "Notes on some spectroscopic binaries", W. E. Harper; "A study of Y Cygni", R. S. Dugan; "Variables in the Scutum Cloud", Miss Margaret Harwood.

Stellar atmospheres, Spectral types, Spectra:—"The nature of the Wolf-Rayet emission", C. S. Beals; "A determination of magnitudes, spectral types, and color indices in the Scutum Cloud, with a statistical discussion", C. J. Krieger; "Contours of lines in spectra of early type stars", C. T. Elvey; "The absorption band at $\lambda 4200$ in stellar spectra", C. T. Elvey and R. S. Zug; "Pressure effects in stellar spectra", Otto Struve; "The stellar calcium lines in spectral types A and B", Otto Struve and C. D. Higgs.

Nebulae and Clusters:—"Are the globular clusters and the anagalactic nebulae related?", and "A general catalogue of nebulae", Knut Lundmark (these two papers read by title); "The nebulous wreath near ϵ Cygni", J. C. Duncan.

Instruments:—"Graduated sphere and co-ordinate frame for reading heliographic positions", R. E. De Lury; "Constructing a 19-inch reflecting telescope", and "The deterioration of silver coats

with age, and a comparison with chromium", R. K. Young; "An accessory device for simplifying measures with the Hartmann spectro-comparator", F. Henroteau.

Miscellaneous:—"New determinations of the curvature radius of space", Ludwik Silberstein. "Newton's library", J. Stokley. Abstracts of the above papers will appear in the regular course in *Popular Astronomy*, and the *Publications of the American Astronomical Society*. Many of the papers will be published in full in the reports of the various observatories or in the astronomical journals.

Mr. J. W. Fecker's lecture on "Engineering in Astronomy", given under the joint auspices of the American Astronomical Society and the Ottawa Centre of the Royal Astronomical Society of Canada, attracted a large audience to the Victoria Museum. Mr. Fecker with the aid of a fine collection of slides described the making of large optical discs of glass, their annealing and the testing of them for strains and striations. He described the mountings of the greatest telescopes, and discussed the engineering limitations to making large telescopes. The possibilities of quartz reflectors and mountings of duralumin were specially mentioned. A hearty vote of thanks was extended to the lecturer for his lucid and interesting discourse.

At the business session on the last day, the following resolution, drawn up by Dr. Frank C. Jordan and Dr. Caroline E. Furness, was adopted:

Resolved, "That the American Astronomical Society expresses its thanks to the many persons who have contributed to the success and interest of this meeting.

First of all to Mr. R. M. Stewart, Director of the Observatory, and his staff who have had general charge of the arrangements.

To Mr. N. J. Ogilvie, Director of the Geodetic Survey, who kindly placed at our disposal the conveniences of his building.

To the Minister of the Interior, who in connection with the officials of the Observatory, sent out the invitation to the meeting.

To Mrs. Stewart and the ladies who offered us such delightful hospitality at various times.

To the officials of the Experimental Farm who furnished the decorations and performed other services.

To Dr. Ralph De Lury who had charge of the press notices.

The memory of this meeting will long remain with those fortunate enough to be present, not only because of the many pleasant events of the meeting itself but also because of the beauty of the city and its surroundings."

Fifty-three members signed the registration-book, and more than this number of friends and relatives attended the meetings also, including a number of members of the Royal Astronomical Society of Canada and of Government scientific departments. Among the visitors who attended the sessions were two distinguished mathematicians, Miss Louise D. Cummings, LL.D., Professor of Mathematics at Vassar College, and J. C. Glashan, LL.D., formerly Inspector of Schools for Ottawa, who in his ripe years keeps keenly alive his interest in scientific developments on some of which members enjoyed discussions with him.

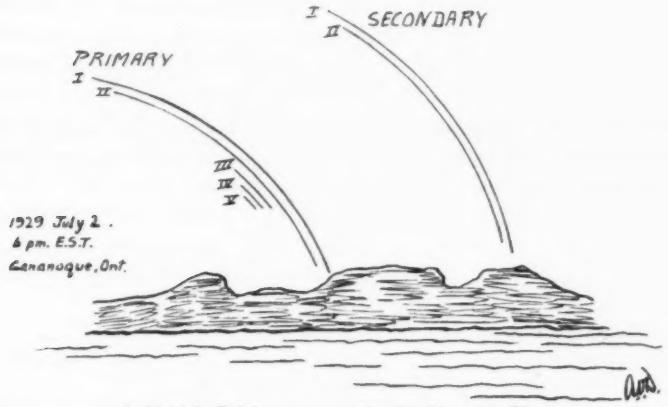
The dinner—always a delightful farewell "session" of the American Astronomical Society—was attended by nearly a hundred. As it commenced we read on the menu that it was being held in the year "minus 3 of the Cotsworth Era": a correct prophecy let us hope, for the adoption of a simplified universal calendar may well aid in ushering in the "Peace Era". Then we read Chant's admonition to the observer concerning the realization of "the true meaning of the things he sees and how he must exercise his reasoning power in order to decide what to accept or reject." Then we found that procedure was facilitated by following Russell, Dugan and Stewart's arrangement of "the various types and classes with whose properties we have become familiar in some rational scheme of evolution—some orderly (g)astronomic sequence." Each item had its sauce: the Salad de Saison was dressed with the findings of a famous scientist—"From realms far distant and pearly, An astronomer with eye watching thoroughly, Returned with a sigh, and as he drew nigh, Said 'I find space, like lettuce, is curly'." Prominent officials of the Department of the Interior were guests: Mr. R. A. Gibson, Assistant-Deputy Minister, Mr. J. D. Craig, Director, Surveys

Bureau, and International Boundary Commissioner, Mr. F. C. C. Lynch, Director, Natural Resources Intelligence Service, Mr. N. J. Ogilvie, Director, Geodetic Surveys, and Mr. J. M. Roberts, Secretary of the Department. Not the least enjoyable part of the dinner was the list of addresses given by President Brown, Mr. Gibson, Mr. Craig, Mr. Stewart, Professor Chant, Professor Kovalenko and Professor Milham: we should like to quote them word for word, but shall close this brief outline by adding to Professor Milham's eulogy of the family spirit radiating throughout the meetings of the Society and the agreeable ease with which its papers are presented and helpfully discussed, the expression of the pleasant sentiments of the staff of the Dominion Observatory in having the good fortune of meeting old friends again and making new ones, and as emphasized by Mr. Gibson and Mr. Stewart, deriving fresh inspiration from the contact.

A MULTIPLE RAINBOW SEEN ON THE ST. LAWRENCE RIVER.

By A. Vibert Douglas

On July 2, 1929, at about 6 p.m., E.S.T., a gusty west wind brought showers over the Thousand Islands near Gananoque, Ontario, and a rainbow was seen having certain features never before observed by the writer.



A Multiple Rainbow seen on the St. Lawrence River.

The primary bow was very intense. The violet of its inner edge merged into another but fainter red, yellow, and green bow. The fainter secondary bow also showed this double effect. But the unusual feature was that near the base of the primary bow there were clearly visible, for several minutes, a third and fourth reddish-violet band and momentarily a fifth was distinctly seen against the dark grey-blue background of the sky. Between the third and fourth a faint yellow and green were just distinguishable, but only the red-violet bands of the fourth and fifth were seen. The accom-

panying sketch indicates approximately the positions of the successive bows, as drawn immediately afterwards from memory. The following estimates of relative intensities are likewise from memory and are based on an arbitrary scale with 1 for the bow just visible P.V. and 10 for the intense outward rim of the primary bow P.I.

Rainbow	Relative Intensity	Approximate Duration.
P. I.	10	5 min.
P. II.	8	5
S. I.	7	5
S. II.	5	5
P. III.	4	2
P. IV.	2	1
P. V.	1	momentary.

If this beautiful phenomenon is as uncommon as the writer's experience and observations would lead one to believe, then it seems to deserve to be placed on record.

LIST OF REFRACTING AND REFLECTING TELESCOPES

By W. E. Harper

In the preparation of an address a couple of years ago on "Famous Observatories" and in recent Radio Talks on "New Observatories", the writer has accumulated a few notes as to the sizes of the instruments at various observatories. It has seemed that the publication of such a list might be of some interest to our amateur members, and accordingly the accompanying list is given. While it is not guaranteed to be complete, it doubtless is nearly so, although the diameters which are given in inches may not in every case be correct as to the decimal figure. Occasionally one finds published statements that conflict. In the list of refractors, the Van Vleck lens is put down as 20.0 inches although Slocum in the *Publications* of the *American Astronomical Society*, III, 224, 1916, gave the diameter as 18.5 inches. A few other such uncertainties exist. The list is arranged in decreasing order of size down to 15 inches, and the "Remarks" column includes the maker, when known, and other information. Space would prevent a description of the work in which the telescope is engaged.

REFRACTORS

Location	Diameter inches	Remarks
South Russia	41.0	Grubb. Installed 1928 .
Williams Bay, Wis., U.S.	40.0	Clark. Gift Yerkes.
Mt. Hamilton, Cal., U.S.	36.0	Clark. Gift Lick.
Meudon, Paris, France	32.7	
Potsdam, Germany	31.5	Steinheil
Allegheny, Pa., U.S.	30.0	Brashear. Gift Thaw.
Pulkowa, Russia	30.0	Clark
Nice, France	30.0	Henry
Greenwich, England	28.0	Grubb
Bloemfontein, S.A.	27.0	McDowell. Univ. of Michigan
Vienna, Austria	27.0	Grubb
Johannesburg, S.A.	26.5	Grubb. Union Observatory.
Greenwich, England	26.0	

Charlottesville, Va., U.S.	26.0	Clark. Univ. Virginia.
Washington, D.C.	26.0	Clark. Naval Observatory.
Johannesburg, S.A.	26.0	McDowell. Yale Photographic.
Tokio, Japan	25.6	Zeiss, under construction.
Berlin, Germany,	25.6	Archenhold Observatory.
Berlin, Germany,	25.6	University Observatory
Belgrade, J.-S.	25.6	Zeiss.
Cambridge, England	25.0	Cooke. Newall Observatory.
Cape Town, S.A.	24.0	Grubb. Photographic Victoria telescope.
Flagstaff, Ariz., U.S.	24.0	Clark. Lowell Observatory.
Swarthmore, Pa., U.S.	24.0	Brashear. Sproul Observatory.
Cambridge, Mass., U.S.	24.0	Photographic doublet.
Oxford, England	24.0	Grubb. Photographic Radcliffe Observatory.
Santiago, Chile	24.0	Grubb. National Observatory.
Lembang, Java	24.0	Zeiss. Double Telescope.
Bergedorf, Germany	23.6	Zeiss.
Meudon, France	23.6	Photographic.
Paris, France	23.6	Photographic.
Princeton, N.J., U.S.	23.0	Clark. University Observatory.
Edinburgh, Scotland	22.0	City Observatory.
Oakland, Cal., U.S.	20.0	Brashear. Chabot Observatory.
Denver, Col., U.S.	20.0	Clark Saegmuller. Denver Univ.
Middleton, Conn., U.S.	20.0	Van Vleck Observatory.
Stockholm, Sweden	20.0	Projected.
Paris, France	19.7	Private Observatory.
Potsdam, Germany	19.7	Astrophysical Observatory.
Milan, Italy	19.2	Merz-Repsold.
Strasbourg, France	19.2	Merz-Repsold. University Observ.
Manila, Philippines	19.1	Merz-Saegmuller.
Evanston, Ill., U.S.	18.8	Clark. Dearborn Observatory.
Rio Janeiro, Brazil	18.1	Cooke.
Philadelphia, Pa., U.S.	18.0	Breashear. Flower Observatory
Oxford, England	18.0	Grubb. Radcliffe Observatory.
Buffalo, N.Y., U.S.	18.0	Private observatory.
Amherst, Mass., U.S.	18.0	
Cape Town, S.A.	18.0	Clark. University Observatory. graphic.
Oxford, England	18.0	Grubb. Finder for guiding photographic.
La Plata, Argentine	17.0	Gautier.
Northfield, Minn., U.S.	16.3	Brashear, Goodsell Observatory.

Rome, Italy	16.1	Merz. Vatican Observatory.
Cincinnati, Ohio, U.S.	16.0	Clark. Union Observatory.
Cambridge, Mass., U.S.	16.0	Photographic doublet.
Mt. Lowe, Cal., U.S.	16.0	Clark.
Madrid, Spain	16.0	Grubb.
Heidelberg, Germany	16.0	Portrait lens.
Athens, Greece	15.8	Gautier.
Nice, France	15.8	Gautier.
Berlin, Germany	15.7	Steinheil-Toepfer. Astrographic
Coimbra, Portugal	15.7	Secretan.
Shanghai, China	15.7	Gautier. Jesuit Observatory.
Heidelberg, Germany	15.6	Brashear, Photographic.
Collurania, Italy	15.4	Cooke.
Toulouse, France	15.4	
Rome, Italy	15.4	Steinheil, Royal Observatory.
Landstuhl, Germany	15.2	Merz. Private Observatory
Pulkowa, Russia	15.0	Merz-Mähler.
Munich, Germany	15.0	Date of 1838.
Vienna, Austria	15.0	Coudé type.
Uccle, Belgium	15.0	Cooke-Merz.
Nice, France	15.0	Gautier
Paris, France	15.0	Henry. National Observatory.
Bordeaux, France	15.0	Merz-Gautier
Lisbon, Portugal	15.0	Merz-Repsold.
Bucharest, Roumania	15.0	Merz, double, visual and photographic.
Moscow, Russia	15.0	Repsold, double, visual and photographic.
Hyderabad, India	15.0	Grubb
Barcelona, Spain	15.0	Two photographic objectives.
Cambridge, England	15.0	Huggins. Solar Physics Obsy.
Stonyhurst, England	15.0	
London, England	15.0	Grubb. Royal Society telescope.
Ewhurst, England	15.0	Coelostat, Evershed.
Edinburgh, Scotland	15.0	Grubb. Royal Observatory.
Northumberland, England	15.0	Grubb. Twin telescope visual and photographic.
Aberdeen, Scotland	15.0	Lord Lindsay telescope.
Mississippi, U.S.	15.0	Grubb.
Cambridge, Mass., U.S.	15.0	Merz and Mähler.
Columbia, S.C., U.S.	15.0	
Berea, Ohio, U.S.	15.0	Projected.
Tacubaya, Mexico	15.0	Grubb.
Ottawa, Canada	15.0	Brashear.

REFLECTORS

Near Pasadena, Cal., U.S.	200.0	Projected
Mt. Wilson, Cal., U.S.	100.0	Ritchey
Parsonstown, Ireland	72.0	Rosse—No longer in use.
Victoria, Canada	72.0	Brashear
Delaware, Ohio, U.S.	68.	Mirror being ground
Mt. Wilson, Cal., U.S.	60.0	Ritchey
Cambridge, Mass., U.S.	60.0	Common, being refigured
Cordoba, Argentine	60.0	Grubb, about completed.
Texas, U.S.	60.	Projected for University; size uncertain
Berlin-Babelsberg, Germany	49.2	Zeiss.
Melbourne, Australia	48.0	Grubb
Paris, France	47.2	Martin and Eichens National Observatory
Berlin, (Neu-Babelsberg), Germany	47.2	University Observatory
Flagstaff, Arizona	42.0	Clark. Lowell Observatory.
Crimea Peninsula, Russia	39.7	Grubb. Simeis Observatory.
Merate, Italy	39.5	Zeiss.
Bergedorf, Germany	39.4	Zeiss.
Meudon, France	39.4	
Geneva, Switzerland	39.4	Schaer
Stockholm, Sweden	39.0	Under construction
Ann Arbor, Mich., U.S.	37.5	Brashear. Detroit Observatory
Ealing, England	37.0	Common and Calver.
Santiago, Chile	37.0	Brashear. Formerly D. O. Mills Observatory.
Mt. Hamilton, Cal., U.S.	36.2	Grubb. Crossley telescope.
Parsonstown, Ireland	36.0	Rosse—No longer in use.
Cambridge, England	36.0	Under construction.
Edinburgh, Scotland	36.0	Grubb.
Tucson, Ariz., U.S.	36.0	Steward Observatory.
Toulouse, France	32.7	
La Plata, Argentine	31.5	Gautier.
Marseilles, France	31.5	Foucault and Eichens, National Observatory.
Toulouse, France	31.5	Foucault.
Salcombe, Sidmouth, England	30.0	Common. Lockyer Observatory.
Helwan, Egypt	30.0	Reynolds. Photographic.
Allegheny, Pa., U.S.	30.0	Brashear. Keeler Memorial Telescope
Washington, D.C.	30.0	Grubb. Heliostat Smithsonian Institution.

Greenwich, England	30.0	Photographic.
Mt. Wilson, Cal., U.S.	30.0	Coelostat and 24 in. concave mirror
Urbana, Ill., U.S.	29.5	Brashear. University Observatory
Harborne, England	29.5	Reynolds. Private Observatory.
Heidelberg, Germany	28.4	Zeiss.
New York, U.S.	28.0	Brashear. Old telescope
Edinburgh, Scotland	25.6	Calver.
Williams Bay, Wis., U.S.	24.5	Ritchey.
Towlaw, England	24.0	Calver.
West Meath, Ireland	24.0	Grubb.
Edinburgh, Scotland	24.0	Grubb.
Bloemfontein, S.A.	24.0	Bruce Telescope, Harvard.
Lawrence, Kansas	24.0	Pitt. Under construction.
Stara Dala (Ogyalla), C.S.R.	23.6	Zeiss.
Budapest, Hungary	23.6	Zeiss.
Berlin, Germany	22.0	Goerz. Technical School Obsy.
Salcombe, Sidmouth, England	21.0	Siderostat, Lockyer Observatory.
Mandeville, Jamaica	21.0	G. H. Hamilton.
Lucerne, Switzerland	20.0	
Glasgow, Scotland	20.0	Breadalbane.
Allegheny, Pa., U.S.	20.0	
Ottawa, Canada	20.0	Coelostat.
Alger, France	19.7	Foucault.
Pyrenees, France	19.7	
Toronto, Canada	19.0	Young, University Observatory.
Armagh, Ireland	18.5	Calver, gift of Director.
Leeds, England	18.3	University Observatory.
Cambridge, England	18.0	Huggins.
Towlaw, England	17.5	Calver.
Warren, Pa., U.S.	16.6	Steber and Thurn.
Cambridge, England	16.0	Coelostat.
Bloemfontein, S.A.	16.0	Harvard Station.
Innsbruck, Austria	15.8	University Observatory.
Berlin, Germany	15.7	Goerz. Optical Works, Obsy.
Kobe, Japan	15.0	Grubb. Coelostat Marine Obsy.
Dunsink, Ireland	15.0	
New Haven, U.S.	15.0	Coelostat.

ARTICLES ON ASTRONOMY FOR THE NEWSPAPERS

By W. E. Harper

For some years past the writer has felt the need of enlisting the services of the daily press in disseminating a knowledge of the elementary facts of astronomy. It is true our own Journal and others of a similar nature are read by a goodly number who belong to our Astronomical Society at the various Centres throughout Canada. Our members we trust, thus derive some knowledge of the wonderful universe in which we live but their numbers are relatively so small that it would seem necessary to try and reach the great mass of the people—the ,'average man of the street", so to speak, through the medium of the daily press.

Indeed, the fact that we have considerable space in both Canadian and American papers given over to "Horoscopes" and similar misleading articles makes it almost imperative for our Astronomical Society of Canada to combat such foolishness by presenting to the public the ascertained facts of the universe in language which will be readily understood by the average reader. Moreover, many of our papers feature news items from sources outside of Canada, when possibly, right in their midst, equally authentic information could be secured upon the subject. It would seem that it would aid in the development of a national consciousness if our Canadian readers felt that they did not always have to depend upon outside sources for such knowledge.

Some preliminary discussion took place between the writer and a representative of a syndicate of papers in the early part of the year and at an informal meeting of the Executive of the Society and other interested persons in Toronto in April the matter was very favourably considered. Professor C. A. Chant and Mr. F. T. Stanford were asked to serve with the writer in making arrangements with the Southam Press for the publication of such a series of articles of a popular nature on Astronomy. Without in any way desiring it, the honour of carrying through the arrangements has

been left largely with the writer and fairly satisfactory arrangements, it is felt, have been completed.

The articles which will appear fortnightly, beginning on September 28th, will be short and, we trust, sufficiently clear and simple that they will be widely read. Thus one of the aims of our Society —the diffusion of astronomical knowledge—will, in a measure, be met by these articles. Moreover, the Treasury of our Society will be enriched to a considerable extent and it will be possible in future years to make larger grants to the various Centres for the carrying out of the work. It might not be too much to hope, also, that funds would accumulate sufficient to obtain a small instrument for the use of members.

It is expected that about a score of the leading astronomers and physicists in Canada will be contributors to the series. Nearly all the articles will be illustrated. As tentatively arranged so far, the topics and writers are as follows:

"Autumn Skies"	Prof. C. A. Chant
"The Ottawa Meeting"	Director R. M. Stewart
"Rotation of the Universe"	Dr. J. S. Plaskett
"Distances of Stars"	Prof. H. R. Kingston
"Sun Spots"	Dr. R. E. DeLury
"The Moon"	Prof. L. A. H. Warren
"Comets"	Prof. J. W. Campbell

The present writer hopes to add an article also and many others, both east and west, will give variety to the series. The Southam Press are arranging to distribute to papers other than those in their own chain.

Dominion Astrophysical Observatory,
Victoria, B.C.

DISCONTINUANCE OF THE CHILEAN OBSERVATORY OF THE UNIVERSITY OF CALIFORNIA

The University of California Lick Observatory station at Santiago, Chile, which for a quarter of a century has given California representation in the southern hemisphere of the globe, 6,000 miles or more from the main campus, has been closed.

The regents of the university have given approval to the final report of the sale of the observatory equipment to the Catholic University of Chile, and the disposition of the funds thus secured.

The observatory at Santiago, on Cerro San Cristobal, was established in 1903 for the purpose of obtaining data on the radial velocities of stars in the southern hemisphere of the sky in connection with a survey being made by Dr. W. W. Campbell, now president of the university. The cost of the station was met by the late D. O. Mills, at that time a regent.

It was expected that the work would require two years to complete, but the task proved to be many times more complex than was thought; almost 25 years elapsed before the required data could be accumulated. Among other things it was found that about one out of four supposedly single stars was in reality double or multiple stars composed of two or occasionally more stellar bodies revolving about each other.

During the quarter century of observation at Santiago, almost $200,000 was spent in staff salaries and equipment, which came entirely from private gifts, though the results of the work have redounded to the credit of the university and of the state. The final results of the survey were recently published by President Campbell and Astronomer Joseph Haines Moore.

After the death of Regent D. O. Mills, the chief contributors to the support of the work at Santiago were: Ogden Mills, William H. Crocker, Mrs. Crocker, F. W. Bradley, A. B. Spreckels, Gordon Blanding, Dr. Ambrose Swasey, George B. Douglas, William B. Bourn, Alexander F. Morrison, Mortimer and Hubert Fleishhacker, the Carnegie Corporation, Phillip E. Bowles and an anonymous alumnus of the university.—(*Science*, Sept. 20, 1929.)

RADIO TALKS ON ASTRONOMY, OVER CFCF, VICTORIA, B.C.

By W. E. Harper

XX.—Can One's Fortunes be Foretold by the Stars?

(June 12, 1929)

If one may judge by the widespread practice of publishing horoscopes in the press, there would seem to be quite a number of people who believe that our fortunes can be read in the stars. On a recent trip to the east I have had occasion to glance at the daily papers of many cities on both sides of the international line, and I find that our own city is not the only one in which these syndicated predictions are published.

The pseudo-science which professes to devise methods for foretelling the future in this way is known as astrology. It is based on the assumption that the celestial bodies influence and determine our human affairs even in their most minute details, or at least that some correspondence exists between the configuration of the heavenly bodies and our mundane affairs so that by properly interpreting the former we may become acquainted with the latter.

Those who do so believe may not be far removed from the rest of us who have our own particular forms of superstitious belief. Some of us may consider it bad luck to see the moon over our left shoulder, to break a looking-glass, to raise an umbrella over us in the house, or to have 13 seated at the dinner table. If we plead not guilty to these we may possibly have others of a similar nature.

Of the many forms of superstition that have afflicted us, without doubt the most interesting is astrology. It has existed for so long a time and over such a large portion of the earth. Many prominent persons have been under its sway and naturally there are many references to it in literature. As it, in earliest days, was associated with astronomy and required a certain amount of scientific knowledge for its practice there was thus thrown around it a glamour and dignity which would not otherwise have been the case.

It was cradled in the valley of the Euphrates and so dates back to remote antiquity. In Babylonia it was one of the two chief means at the disposal of the priests for ascertaining the intention and will of the gods, the other being through the inspection of the liver of the sacrificial animal. I digress just to say that as the liver was supposed to be the seat of the soul it would, therefore, be in accord with and reflect the mind and will of the deity which accepted the sacrifice. As for astrology, it was natural for primitive races to look upon the sun that warmed them by day and the moon that lightened their darkness by night as reigning in the heavens and which ought to be worshipped. It became very easy for them to pass to the thought that these heavenly bodies influenced human beings and thus came the urge to divine the intention of the gods concerning them. The earliest efforts, dating around 3,000 B.C., concerned the welfare of communities only and not of individuals, except in so far as the chief or king was supposed to represent the tribe or country. Forecasting for individuals was a later development.

Only the more noticeable of the heavenly bodies, the sun, moon and the then-known planets, were at first used. Later the positions of these more conspicuous heavenly bodies with reference to the star groups also called for consideration. If some great event like the death of a king occurred whilst Saturn occupied a particular position among the groups, that fact would be duly chronicled by the priests to serve for future prediction. There thus arose a great mass of observational data but, as we now see, there was no connection between the event and the cause prescribed. Moreover, in time the very multiplicity of events of a contradictory nature that were ascribed to the same configurations of the heavenly bodies eventually brought discomfiture to the astrologers. Like modern dissemblers, they issued their prophecies in very vague and contradictory terms so that almost anything could be read into the horoscopes they cast. Listen to a phrase or two from a horoscope clipped from a recent daily: "Threatening stars again seem to dominate, according to astrology". . . . . and later in the very same

horoscope: "Even though the stars seem to smile" . . . . . How contradictory! And what are we to make of this sentence? "After sundown the signing of contracts or the writing of business letters should be reasonably well directed." Are we to infer that on that particular day while the sun was up, he, the sun, would see that all imperfections in business letters would be straightened out, but that after he had set the writer must look to himself and be more careful in his diction. Such piffle would indicate that modern casters of horoscopes have not departed from the methods of the early Chaldeans.

The Greeks who penetrated the Euphrates valley were inoculated with the art and on returning home introduced astrology into their own land about the middle of the 4th century B.C. There it gradually gained ground and passed into acceptance as one of the modes of divination. In the hands of these gifted people it received a precision and finish that imparted to it the false lustre of a scientific method. It is quite possible though that many clever Greeks practised astrology for the great profit it brought in, without being themselves deceived by its absurdity.

Astrology is referred to several times in the Old Testament, but never with approbation. The prophets and leaders of the chosen race continually warned their people against worship of the heavenly bodies and against the idea that these bodies dominated human affairs.

From Greece the art passed into Italy and although an edict was passed in 139 B.C. expelling the astrologers, and although Cicero declaimed against it, pointing out that not one of the futures predicted for Cæsar, Pompey or Crassus was verified, yet the practice remained much in vogue.

From Italy the practice spread all over the continent of Europe In the middle ages it fairly "boomed". It had now become associated with chemistry and medicine and almost every physician and man of science in mediæval Europe was an astrologer. Medicinal practice and astrological prediction went hand in hand. There is a survival of this connection to-day for the sign which heads the

prescription of the physician is none other than the symbol for the planet Jupiter. Even the great astronomer Kepler, who enunciated fundamental laws in astronomy governing planetary motions that still stand to-day, was not averse to maintaining himself by casting horoscopes. "Nature," he wrote, "which has conferred upon every animal the means of subsistence, has designed astrology as an ally of astronomy". His language suggests that he realized its possibilities for financial profits for he charged heavy fees and died wealthy. If present day astronomers had a similar code of ethics they, too, might amass wealth, for people are still gullible.

A good story is told of Flamsteed, the first Astronomer Royal of England, who did not believe in such deception. An old lady lost some jewels and appealed to the observatory to aid her in finding them. Flamsteed refused, but being continually pestered with her he finally decided to cast a horoscope—which would give a false prediction, of course—thereby destroying her confidence in him. Making a sketch of her house and grounds he inserted a few magic signs to give it the flavour of a real horoscope and then quite at random indicated a point to dig and find her jewels. The curious part is that she did dig in that spot and found the jewels and her confidence in the observatory was thus in nowise diminished. Of poor Flamsteed it is said that he attributed the result to the direct action of the devil. This story, quoted from a reliable authority, is quite possibly true, and it simply serves to show that once in a while the truth will be hit upon as indeed the laws of probability in mathematics tell you must be the case.

Up to the time of the middle ages, the earth was supposed to be in the centre of things with all the other celestial bodies revolving around it. While this earth-centred idea persisted, astrology flourished but real astronomy made no advances. With the acceptance of the Copernican system in the middle of the 16th century, a marked change was noticed. In this system the sun is at the centre of our solar system with the planets revolving about it in known periods of time, whilst the stars are suns in themselves at immense distances from our own system. People began to think for them-

selves and to realize how absurd it was to imagine that these distant bodies could exert any influence upon human beings on the earth. Astrology thus gradually fell into disuse.

But it has not completely died out. One reason, as I have indicated, is that the predictions are given in such a vague manner that you can read almost anything into them. Coupled with that is the universal desire to peer into the future. Certain classes of people in businesses with factors beyond their control are more susceptible to astrology than others more firmly established. I believe that many, who as amateurs are given to speculation, carry their horoscopes and consult them to see if it will be a lucky day for buying or selling.

Among primitive peoples, with the forces of nature around them but little understood, we can appreciate their groping after anything that purported to reveal the will of the gods concerning them. Today we have learned a great deal, not only about the planets and their motions, but about the distant stars as well. We can compute the positions of, and plot the configurations which the planets will have with respect to the stars on any day desired, centuries hence, if need be, and who would be foolish enough to believe that thereby we can foretell everything that is in store for the oncoming generations? Moreover, by delicate electric thermometers weighing less than 1/1000 of a drop of water, we can measure the heat coming from the stars. The one which sends us most is Betelgeuse in Orion, and even its rays when concentrated by the great 100-inch telescope on this sensitive thermometer are able to raise its temperature only 1/60th of a degree above that of the clear sky. How ridiculous to imagine such feeble radiations as influencing human kind.

"When I was a child I spake as a child, I understood as a child, I thought as a child, but when I became a man I put away childish things." If we consider ourselves a part of the twentieth century we ought to act the part.

XXI—Discoveries in Astronomy

(July 10, 1929)

My purpose is to speak of some general principles underlying astronomical research rather than to enumerate particular discoveries that have been made. And first of all I wish to disabuse your minds of the all too prevalent idea that the astronomer sits with his eye glued to the telescope, peering into space in the hope that some new planet will 'swim into his ken'. That may or may not have been the routine a few centuries ago when telescopes were first invented but it is certainly not true to-day. The great majority of the observations to-day are photographic, plates being secured at night, according to a prearranged programme, and studied at our leisure in the day time.

The first point I would make, then, is that *chance discoveries are few*. Of course nearly every rule has its exceptions and some exceptions to this rule are of interest. While taking photographs of the sky at Oxford, England, in the early years of this century it happened that a batch of plates used on a certain night were not of the usual sensitiveness and consequently when developed next morning were all slightly too weak for the required purpose. Having to repeat the observations a few nights later it chanced that the astronomer compared two plates of the same region of the sky and noticed a bright object which should have been shown on the defective plate. Investigation showed that it was a 'new' star that had flashed into view and this accidental discovery enabled many observatories to study it as it passed through its various stages before becoming extinct again.

In the case of Morehouse's comet, discovered by him in 1908, I have heard it stated that it was quite by accident he pointed his telescope to the particular region where the comet was at the time. If such be true it was certainly a lucky accident as this was one of the best observed comets of recent times and one from which we learned much regarding the character of these filmy members

of our solar system. Such accidental discoveries are, as just stated, very rare.

A guiding principle that is a safe one in any line of research is to first *get the facts by observation.* While we cannot hope in our lifetime to learn all the facts about each star, the greater the number of our observations the more likely are any conclusions we arrive at to be sound. So often far-reaching conclusions are based on all too meagre data with the result sometimes that these conclusions must be abandoned, when additional observations have told heavily against them. It is better to have your foundations broad and deep; then the superstructure you rear will not be likely to collapse.

There are thus two aspects to reaserch work, the observational and the theoretical. Particularly is this true in astronomy and while, as just stated, your foundation of facts must be broad-based it would be unwise to do no theorizing while securing the observations. The best working arrangement is to try your results out, as you go along, on the theory you have tentatively in mind. They may substantiate it, may be in complete disagreement with it or may be inconclusive. In the latter case they may suggest new observations that will be more conclusive. The important thing is that *theory and observation* should go hand in hand.

Let me cite a couple of illustrations to bear out this idea. While we still speak of the stars as the "fixed" stars it has long been known that they have motions across the sky which, while too small to be recognized by the naked eye, are nevertheless real and measurable. At one point of the heavens it seemed that the stars in the neighbourhood were closing in, whilst in the region diametrically opposite they appeared to be opening out. This could be explained if our solar system were moving in space towards the region where they were opening out. Such observations suggested an examination of stellar motions midway between these two points and when these were found to be directed backwards there was little doubt of the reality of the motion of the sun through space. At that time it was not possible to measure the velocity of a star towards us or away from us but it was recognized that if such were ever possible then

the stars in the region of the sky towards which we are heading should on the average have high velocities of approach, whilst those in the opposite quarter should similarly have high velocities, but of recession. Time has justified the conclusions then arrived at and such radial velocities now tell us we are moving at 12 miles per second towards a point in the heavens south and west of Vega.

Another interesting illustration of the value of a theory as a guide to observations is revealed in the discovery of the planet Neptune. The seventh planet, naming them from the sun outwards, is Uranus, discovered by that assiduous watcher of the skies, Herschel, in 1781. Its orbit around the sun was computed from the first few years' observations but it was found that it failed to keep in the path prescribed for it. It began to be suspected after 40 years that the cause was another, as yet undiscovered, planet attracting Uranus and causing these discrepancies. During the next 25 years a wealth of observational data were gathered of these variations from straight orbital motion and mathematicians in France and in England working upon such irregularities were able to state that the body causing the perturbations of Uranus could then be found in a definite region of the sky. The telescope was directed to that portion of the sky and Neptune stood revealed. Here, then, was a case where the theoretical or mathematical astronomer really made the discovery.

It does not necessarily follow that every class of astronomical observation calls for theory to accompany it. For nearly forty years eighteen observatories have been co-operating in photographing the heavens on a scale mutually agreed upon. This permanent record, now almost completed, will be available for comparison to all who come after us, who will thus be able to note any additions to or changes in the map of the heavens. Of a similar self-sacrificing character is the work on visual double stars, for in the case of most of them one lifetime is insufficient to witness a complete orbital revolution. Nevertheless their changing positions, even though snail-like, must ever be recorded so that the next generation may find no gaps in the observed path when they come to determine the definite orbit.

The ultimate goal of all astronomical research is the complete

understanding of the form and construction of the stellar universe and for the most part such researches call for a wise combination of observation and theory. It may not always be advisable to carry on both at the one institution or in one country. America to-day, particularly the western coast of America is the great beehive for the observational side of astronomy. Until recently nearly all the large telescopes of the world have been located here, owing to the favourable climatic conditions for astronomical work. Europe on the other hand has a very poor climate for observation and the skies are rendered even worse by the smoke from manufacturing establishments. Consequently European astronomers stress the theoretical side more and some of the outstanding men in the science are those of England and Holland, Sweden and Germany. While all observatories like to work up their observations as completely as possible yet, if the instrument is to be kept busy, the pressure of the observational programme usually results in the observations being given to the world in a more or less raw state. The theoretical astronomers with more time for detailed study can then make finer deductions and by relating to other classes of data may draw far reaching conclusions. Astronomy knows no national boundary lines, for astronomers are one great fraternity the world over.

XXII—The Rôle of the Amateur in Astronomy

(August 14, 1929)

There is a feeling current among us that discoveries in astronomy, or indeed in any of the sciences, can only be made with costly instruments in the hands of professional scientists. It is of course true that the better equipment one possesses the greater will be the chances of successful investigation of any problem, but it is nevertheless also true that much can be done with very simple apparatus, and that too in the hands of amateurs.

It is with the idea of calling attention to some splendid contributions of amateurs in the past to the subject of astronomy and of pointing out phases of work that can profitably be undertaken

by them in the present day that I devote these ten minutes over the radio.

And first let me speak of the great English astronomer, Herschel, who started as an amateur and who as an amateur made most valuable contributions. At the age of thirty-eight he was appointed organist at the chapel in Bath and soon was busy in giving lessons and concert work and in composing. Nevertheless he found time for reading and became so interested in astronomy that he wished to have a telescope to view the heavenly objects he was reading about. Not having the money to buy one he set to work to grind and polish the mirror for his own reflecting telescope. Night after night when his usual day's work was done, would he sit studying the stars as they drifted across the field of his telescope. One night in the year 1781 he noticed something passing through the field that was not like a star, being more extended than the star-like points. Noting from night to night that it changed its position relative to the stars, he concluded it was a comet but later came to realize as he continued the observations that it was another planet he had discovered. Thus was Uranus, the seventh-known planet, discovered by an amateur in his spare time. Subsequently King George III gave him a pension so that he could devote more of his time to astronomical work, with the result that he made many discoveries relating to the form and dimensions of the universe.

I next pass to the discovery in 1843 of the periodicity of sun spots by Schwabe, an amateur student of the sun. The dark blotches upon the sun that had been noted by Galileo when he pointed the first telescope to our luminary about 1610 were thought to occur rather haphazardly and indeed in Schwabe's day astronomers considered the observation of the numbers and character of these spots a useless piece of work.

But for seventeen years before he made his definite announcement Schwabe had, in the face of such discouragement, been patiently observing the sun with his little telescope and noting if there were any spots, and if so, their number and size. Year by year he had communicated the results of his daily counting of the solar spots to the German Astronomical Journal and after ten years had been completed he realized that the sun spot cycle, now so well

known, was shown in his summarized observations. He waited, however, for another seven years for ample verification before making his definite announcement in 1843.

Curiously enough it was fully eight years more before his discovery attracted the attention of the regular astronomers who were slow to see the tremendous importance of this waxing and waning of the sun spots. We now know that with the increase in the numbers of the sun spots there is an increase in magnetic storms upon the earth and in the frequency of the auroral displays. Many other phenomena, vitally connected with the welfare of human kind, are also thought to be dependent upon this variation which was established by an amateur, even in the face of discouragement from professional astronomers.

Coming down to more recent days, we have the case of a young court stenographer, Burnham by name, becoming interested in astronomy and securing eventually a six-inch telescope to carry on his observations on double stars. Mounting this in his back yard in Chicago he continued the work begun by him with smaller instruments. He improvised a driving clock by means of sand pouring out through a fine hole in a cylinder and was thus able to make his telescope follow the stars across the sky. With it he discovered several hundred new double stars and determined the orbits of not a few of those of shorter period. The leading observatories in the United States were glad to have him use their telescopes for short periods and with these larger ones he was able to supplement the observations with his smaller instruments. After 20 years of marked success as an amateur in his chosen field of double star astronomy he was called to the regular staff of the University of Chicago where he utilized to the fullest the great forty-inch telescope established there in 1898. Before his death some years ago he had issued a monumental catalogue of 13,665 double stars, the standard book of reference at the present time.

The great development of photography as applied to astronomy may be said to have been stimulated, if not originated, by amateurs. Some enterprising photographers at Cape Town were trying to photograph the great comet in 1882 but were not very successful until they were encouraged by Gill, the Astronomer at the Cape,

to attach their cameras to the tube of the telescope so that its changing position could be followed. The resulting pictures attracted such attention when sent to Europe and elsewhere that photography ever afterward was looked upon as an ally of astronomy.

And now for some fields of investigation that are suitable for amateurs of the present day. While eclipses of the sun are extremely rare phenomena in any one locality, use has been made of amateur observers, scattered on each side of the central line of totality, to determine the exact limits of the shadow and thus to deduce corrections to the moon's position. In the case of eclipses of the moon which are more numerous there are opportunities for those interested in photography to determine, by means of color screens, the character of the light of the eclipsed moon. Only very rarely is it absolutely darkened. Then, too, by a very simple set of screens, furnished to volunteer observers in different parts of the world, Lord Rayleigh has, from the combined results, been able to detect seasonal variations in the color of the night sky.

The observation of meteors is an important work that can be carried out by amateurs and to many it becomes a fascinating game. The little flashes that dart across the sky and lead us to exclaim 'See the falling star!' are caused by very tiny particles of matter. For the most part they are little pieces of stone mixed with iron which, coming into contact with the earth's atmosphere, are set aglow and usually consumed, falling as ashes to the earth. These particles are the remnants of disrupted comets and by tracing back the path of the meteor one can obtain the region of the heavens from which it came, thereby deducing the path in the heavens of the meteoric swarm. The only equipment required is a straight edge or wand, a chart of the heavens and a nodding acquaintance with the brighter stars at least. A live organization exists from which the necessary charts can be obtained.

For the programme of work I am going to suggest finally as being suitable for amateurs, a small telescope is essential. It is for the purpose of noting and recording the brightness of certain stars which vary in their luminosity. They have now become so numerous that a host of observers is required to keep tab on their

fluctuations. The necessity of having a telescope might debar some from entertaining the proposition but in the last few years the making of mirrors for telescopes has become very widespread. The late Mr. F. Moore of this city, who passed away so suddenly in June, last, had all but completed a 10-inch reflecting telescope with the necessary mounting and eye pieces, all of his own handiwork.

In this work too, the observers are very actively organized both in America and abroad. The American Association renders help and advice to all who volunteer to assist. Maps of the heavens, with full directions for locating the variable stars, are issued to each observer and the results are published in *Popular Astronomy*. Many observers are making simultaneous estimates of the brightness of the same star and thus there is the opportunity of checking up your work against others. This is very helpful in the early stages to give you confidence in the accuracy of your measures or to show you wherein you err. But best of all, it is possible to have a continuous record of the fluctuations of any star for the observers being spread over such a wide extent of country it is never likely that cloudy skies will prevail everywhere. When observers in America cease operations, due to daylight coming on, the work is taken up by those in the Orient and when they lay it down it passes into the hands of Europeans so that there is a 24-hour watch maintained if deemed advisable.

XXIII—Some Practical Applications of Pure Science

(September 11, 1929)

It is a truism that there is no discovery made in pure science that does not sooner or later prove to be of some practical service to mankind. No matter whether the one who makes the discovery intends such to be the case or not, the result invariably is that some one sees a practical use for it and makes the application. For some time I have had it in mind to present in one of these short talks an example or two of how readily pure science becomes applied science.

Examples are to be found in all the sciences but it will serve our purpose to select from astronomy and physics only. These two

branches of science are closely interwoven and are becoming more and more so every day. The physicist, or for that matter the chemist, may be analyzing the light from some substance, say oxygen gas, and may find that under certain conditions of temperature and pressure its spectrum consists of certain bright lines. Under other conditions such lines may be missing and their places taken by others. In their laboratories the workers are restricted to a very limited range of temperature and other physical conditions and soon come to the end of their tether. Then they call to their aid the astronomer to study the same gas in the giant cosmic crucibles, the stars, for there, temperatures and other physical conditions, can be selected at will which are unattainable in our terrestrial laboratories. Thus, to-day, there is close co-operation between the physicist and the astronomer to the mutual advantage of both.

Little did the early experimenters in the field of electricity and magnetism think of the many far reaching applications of their studies. To-day we have an electric age, with electricity lighting our cities, furnishing the motive power for vast transportation systems or even carrying the spoken word around the world instantaneously. We who are heirs to these conveniences would do well to pay tribute to men like Galvani, Volta, Ampere, Faraday, Ohm and other pioneers who wrested from Nature the secret of electricity and magnetism.

To turn to the astronomical side now we will take the case of helium. The derivation of the word itself suggests that the sun is concerned and, as a matter of fact, the name was given to an unknown gas which was discovered in the upper amosphere of the sun at the time of the total solar eclipse in 1868. On such rare occasions as total solar eclipses the main light of the sun is blotted out by the moon and we can for a minute or two study the light surrounding the sun, that is, its upper atmosphere. The usual way is to obtain a permanent photographic record of its light as analyzed by passing it through a prism, yielding the well known rainbow colored band or spectrum. In the spectrum are markings or lines which indicate by their positions the presence of gases or metallic vapours. Now at that eclipse a series of markings were noted which had hitherto never been observed in the spectrum of any

substance and to the unknown gas in which the spectrum lines originated was given the name helium.

By studying the conditions in the sun where these lines originated it was possible to predict with what the gas might be associated if it was ever found on the earth. Thus 25 years later, in 1893, it was traced to earth and found, as might be expected, to be a very light gas. It is somewhat heavier than hydrogen, the lightest known gas; but as it has almost equal lifting power and moreover is not inflammable, as is the deadly hydrogen, it is exceptionally suitable to be used in balloons and airships.

At the commencement of the war very small quantities of the gas were available, sufficient merely for ordinary laboratory purposes. So great was the demand for it created by the war that a stimulus was given to its production and large-scale production plants in Texas and in Alberta were in operation before the war was over. It is a far cry from the astronomer examining tiny markings in his spectrum to a rapid round the world flight in an airship supported by this gas that resulted from such purely scientific studies.

And the end is not yet! Some years later this gas was liquefied. It liquefies at the lowest temperature yet secured, namely 269 degrees below zero Centigrade. As a means of testing out other forms of matter at excessively low temperatures it holds out wonderful possibilities and may be the means of prying into more of Nature's secrets. Work along this line is being carried out at the University of Toronto.

Another similar case of a gas long remaining unknown is that of "Nebulium" the name given to an unknown gas in the great nebulous clouds in the heavens. The secret of nebulium was learned less than two years ago by a phyicist playing, as it were, in his laboratory with combinations of numbers. Formerly we considered that the smallest particle or atom of any element was entirely different to that of any other element. An atom of iron was supposed to be radically different to that of carbon. Atoms are known to be infinitely small; there are millions of millions of them in a single drop of water, hence no microscope would ever show the differences if such existed. However, if such a powerful microscope could be made it was felt that atoms of various sub-

stances would be markedly dissimilar. The new and correct conception is that atoms are in their make up all alike, being composed of a nucleus of positive electricity and one or more units of negative electricity circulating about the nucleus. The lightest known substance, hydrogen, has one tiny unit of electricity, called an electron, circulating about the nucleus; helium, mentioned a moment ago as the second lightest gas, has two electrons in motion about the nuclear charge, while an atom of oxygen with its eight electrons revolving about the nucleus may well be likened to a miniature solar system. The various elements can be arranged in a scale of increasing weights with numbers from 1 to 92 and when the roll is called all but a few of the heavier elements have answered to their names and are known to exist. Now it was felt that nebulium must be a light gas and as there were no gaps in the table there it was surmised that it must be some one of the lightest gases in some unusual condition of excitement.

To check this up a study was made of each of the lighter gases in turn to see in how many ways these electrons could change their paths about the nucleus to give out light. Certain ones which would not likely occur under terrestrial conditions were nevertheless possible under the extremely rarefied conditions known to exist in a nebula. Since these combinations would give the observed lines it was thus shown that the unknown gases were none other than the well known gases of our own atmosphere, Oxygen and Nitrogen, masquerading in unusual attire.

Thus has the secret of the illumination of the nebula been wrested by simple mathematical induction; the practical application has yet to come but if ever we can reproduce the luminous efficiency given by the "cold" light of the nebula what a joy will be the householder's in his relief from heavy electric bills.

And if this is an electric age it is also an automobile age. The physicist bombarding atoms of iron or drops of oil with a modified form of X-rays can tell how the electrons are arranged in a crystal-like structure around the central nucleus. Moreover he can diagnose the best structural formation to withstand strain and so can test out the finest of steel. In a similar way his study of the crystalline structure of various oils enables him to state definitely in which one the arrangement is the best for lubricating purposes. How very practical after all are these studies in pure Science.

NEWS AND COMMENTS

Daily observations of the sun's radiation at Mount Brukkaros, British Southwest Africa, will be made by Louis O. Sordahl, who has been appointed to take charge of the Smithsonian Solar Station there. These observations will be used along with the results from the solar stations at Swartout, California, and in Chile, in connection with the problem of long-time weather forecasting.

Mr. Max Adler of Chicago, has given the city $500,000 for the erection of an astronomical museum and a Zeiss Planetarium near the Field Museum. Professor Philip Fox, Director of the Dearborn Observatory, has been appointed director of the Adler Planetarium and has gone to Europe to inspect astronomical museums and planetaria.

Professor Clifford C. Crump has resigned as professor of astronomy and director of the Perkins Observatory of Ohio Wesleyan University, to become professor of astronomy and director of the observatory at the University of Minnesota.

Dr. Harlan True Stetson, assistant professor of astronomy at Harvard University and associated with the faculty for the past thirteen years, has resigned to become head of the department of astronomy and director of the Perkins Observatory, Ohio Wesleyan University at Delaware.

Mr. Roy Marshall, who received the B.A. degree at the Ohio Wesleyan University in June last is now pursuing graduate work in the Detroit Observatory, University of Michigan.

Dr. Frank C. Jordan, professor of astronomy in the University of Pittsburgh, received the honorary degree of doctor of Science, at the ninety-fourth annual commencement of his *alma mater*, Marietta College, on June 17. (*Science*).

Director E. Esclangon of the Strasbourg Observatory has been appointed director of the Paris Observatory; and M. Cooton and

M. Maudin have been elected members of the council of the Observatory, succeeding the late M. Daniel Berthelot and M. Apell, who recently resigned. (*Science*).

Dr. Walter Geoffrey Duffield, Director of the Australian Commonwealth Solar Observatory at Mount Stromlo, died on August 1. (*The Observatory*).

Mr. E. S. Martindale, Natural Resources Intelligence Service, Department of the Interior, Ottawa, Acting Secretary of the Canadian Geographical Society, has kindly contributed the following notes:

"The organization recently in Ottawa of the Canadian Geographical Society at last closes up a noticeable gap of long standing in Canadian institutional life.

"During recent years the leading public men of the Dominion have stated time and again that the thing that is needed in Canada, more than anything else, is that people in every section of the country should become better acquainted with the conditions that exist in other sections. With few exceptions the major political and economic problems of the Dominion are fundamentally the outcome of its physical and economic geography. The work of making the resources and the other geographic factors of each part of the Dominion more widely known and more clearly understood is one of the best educational services that can be undertaken—and one that cannot be rendered except through a geographic organization animated by a broad national purpose and outlook.

"The Canadian Geographical Society is designed to serve that purpose—to make Canada better known to Canadians, and incidentally, better known to outsiders. One of its first activities will be the establishment of a magazine devoted to all phases of Canadian geography—historic, physical and economic; also to such world geography as may be of special Canadian interest.

"Provision is made in the Constitution for honorary members, honorary corresponding members, patrons, fellows, and members.

"The Directors elected on July 30th are:—Dr. Chas. Camsell, F. C. T. O'Hara, J. B. Tyrell, Dr. J. H. Grisdale, Chas. G. Cowan, Dr. O. D. Skelton, W. W. Cory, C.M.G., Lt.-Col. O. M. Biggar, K.C.,

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"A general meeting of the Board is being held on September 19th at which the Officers of the Society will be elected and the executive, membership, editorial and other standing committees formed, thus establishing the organization upon a proper working basis.

"Mr. E. S. Martindale, 238 Sparks Street, Ottawa, is Acting Secretary."

This is of particular interest to members of the Royal Astronomical Society of Canada who wish the new Society every success.

REDeL.

NOTES AND QUERIES

Communications are invited, especially from amateurs. The Editor will try to secure answers to queries.

Death of Dr. E. S. Bieler

It is with deep regret that we record the death of Dr. Etienne S. Bieler, a member of the Royal Astronomical Society of Canada since 1924, and one of the best known and most promising of the younger generation of Canadian men of science.

While Dr. Bieler had never taken part in astronomical or astrophysical research, an interest in the latter was inevitable in one who had been engaged in both the experimental and the theoretical researches of modern atomic physics.

He held the position of Assistant Professor of Physics at McGill University after his return from Cambridge where he had spent three years in the Cavendish Laboratory carrying out a series of experiments on the nature of the fields of force about atomic nuclei.

Recently he was granted two years leave of absence by his

University to become Deputy-Director of a geophysical survey of Australia. It was in the pursuance of this important undertaking that he was fatally stricken with pneumonia in July, 1929.

A scholar of wide culture; a soldier with a gallant record; a teacher, sound and conscientious; an experimentalist of proved ability; a man of energy and enthusiasm, of high principles and noble character—his memory is an inspiration to all who knew him.—*A. V. D.*

A Daylight Meteor

On August 19 at noon a bright meteor was seen at several places at a considerable distance from one another. In the Toronto *Globe* of the 20th was a despatch from Sharbot Lake, north of Kingston, which stated that a large meteor, high in the eastern sky, passed southward over Sharbot Lake, at 12.45 p.m. on the day before. The sun was shining brightly but several persons saw the ball of fire as it rushed by, leaving a trail of blue smoke. In the Toronto *Mail and Empire* of August 20 it was stated that when at Scarboro Bluffs, about ten miles east of the city, Fred Baskerville saw the meteor. He said, "It was a white-looking mass and it seemed to sparkle as it dropped into the water at an angle of about 15 degrees." He stated that it flashed out of the southern sky and dropped into the lake some distance away.

At Go Home Bay, about 100 miles north of Toronto, Mrs. J. C. Robertson saw the meteor. It was seen a little south of east, and as it fell it moved slightly to the north. It had a bluish appearance and its path seemed somewhat jagged. Its altitude was about 30 degrees or a little less.

These reports do not agree in every detail but it was undoubtedly the same object in each case. It is unfortunate that enough observations were not reported to determine its position in space more accurately, but I suppose one can hardly hope for such in the case of a daylight meteor.

TWO MORE FIREBALLS

A report of a meteoric phenomenon was contained in a despatch from Peterborough, Ont., dated September 22. It was stated that

at Stony Lake an object was seen passing rapidly over the trees and dropping into the water with a hissing sound and sending a spray high into the air. At first it was thought to be an airplane, but no trace of it was to be found.

On the evening of September 24, at about 8 o'clock, E.S.T., a bright meteor appeared in the N.N.W., and followed a course southward. It apparently broke into fragments just before disappearing. Many in Toronto saw the brilliant light, some mistaking it for a flash of lightning. It was very brilliant. It was seen also in Hamilton and Buffalo.

ROTATIONAL EFFECT IN EARTHQUAKES

In an article in this JOURNAL of October, 1925 (page 169) Mr. E. A. Hodgson described the remarkable rotation of some of the stone monuments in a cemetery produced by the earthquake of February 28, 1925.

In "Here, There and Everywhere" (page 179) Lord Frederic Hamilton refers to a similar effect in the Jamaican earthquake of January 14, 1907. He says, "I noticed that brick houses suffered more than wooden ones. This was attributed to the inferior mortar used by Jamaican masons, for which there can be no excuse, for the island abounds in lime. Wooden houses escaped scatheless. Every statue in the Public Gardens was thrown down, except that of Queen Victoria. The superstitious negroes were much impressed by this fact, though the earthquake had, curiously enough, twisted the statue entirely round. Instead of facing the sea, as she formerly did, the Queen now turned her back on it, otherwise the statue was uninjured."

C. A. C.

VISIBILITY OF THE CRESCENT VENUS. (By Carl Reinhardt).

Irradiation and auto-suggestion are advanced by your correspondent, Mr. Duff, in the JOURNAL for May-June (p. 230), as accounting for the naked eye observation of the crescent phase of this planet by certain observers.

Auto-suggestion has undoubtedly to be guarded against, since irradiation throws out rays of light which might very easily be

mistaken for the true crescent. The sketch herewith, I made about daylight one morning in May shortly before Venus had reached maximum brilliancy, showing the planet as it appeared to me, the two large rays remaining fixed, and coinciding in position with the form of the crescent as seen through a glass, (though of course much larger), while smaller rays flashed intermittently in different directions.

The letter of another correspondent in March (p. 144), and my own in January (p. 48) eliminate auto-suggestion in each case, since both observations were unlooked for. It must appear also from my letters that deceptive irradiation was being given full consideration in describing my observation, as well as in the suggestions made (p. 114), to eliminate it, chief of which is that the observation be made before darkness has set in. After that, the planet is a blaze of light, far too brilliant to hope to see the disc without optical aid.

Mr. W. F. Denning, in a pamphlet on "The Planets Mercury and Venus", makes some interesting observations regarding conditions necessary in order to see with the telescope surface markings on the latter planet. These would appear to apply with equal force to observing the form of the crescent with the naked eye. Irradiation he overcomes by daylight observation. Atmospheric conditions must be perfect if one is to hope for success. On very few days in the year, he shows, is visibility high enough, except in an unusually favourable climate. The high, dry, desert plateau of Arizona drew Lowell there for that reason, and the astronomer-priests of Chaldea were able to study the skies under somewhat similar conditions.

Since the archæologists tell us that these Chaldean priests knew of the phases of Venus, present day astronomers who deny the possibility of seeing the crescent without optical aid, must assume that the telescope was invented ages before Galileo made his, and with which he immediately discovered Venus's phases.

The lens was known to the ancients. Aristophanes mentions burning glasses in his comedy of the "Clouds". The one found by Layard near Nineveh was plano-convex, cut from rock-crystal,

and was quite well formed. Did the makers of it go a step further, and combine two or more to produce a telescope? It is certainly an interesting question to the astronomer, but it is one for the archæologist to determine.

On the other hand, the latter is justified in asking the astronomer if a knowledge of the phases of Venus may be taken as proof positive that the telescope had been discovered. Are those who

The Crescent Venus as seen with the Unaided Eye (lower) and with an Opera Glass (upper), May 20, 1929.

dispute the possibility of the observation without optical aid, disposed to assume that it had?

There is no doubt that the observation is a most difficult one, under usual atmospheric conditions, and the small angle, 40″ to 1′ of arc, just beyond the limits of average human vision. G. W. Ritchey, discussing telescopic design in the JOURNAL for January (p. 20), states that "a *convention* usually adopted is that the normal human eye can just distinguish the general form of an object which subtends to the eye an angle of four minutes". This, no doubt,

may be a good working assumption to adopt for that purpose, but unobstructed vision, out in the open, may reasonably be expected to do better than it can within an observatory.

Mr. Duff states that he could easily make out the form of Venus with a four-power glass from March 15th, which is equivalent to an angle of 2 2/3 minutes of arc. As a young man, I did a lot of hand level work, the level being without lenses. Figures on the rod one tenth of a foot in height could be read without difficulty at 100 feet, equivalent to less than 3½ minutes of arc. These figures were black on a white ground.

Who that has lived out in the open, in the clear air of the north, or the prairie or the desert, does not know of the occasional brilliantly clear morning, when visibility is so high that one can see remarkable distances, and details of landscape, usually quite indistinguishable? Under such favourable atmospheric conditions it is not unreasonable to expect that an object of such dazzling brilliance as Venus could be seen much better than an ordinary object of the same size, provided irradiation were eliminated.

After giving impartial consideration to the arguments of those who state the feat impossible, and only desiring to get at the truth, I remain convinced that on the occasion described in my letter, it was the actual body of the planet which I observed, and while it would seem that this conjunction of the planet has passed with but one additional confirmation of Proctor's statement that it was possible, perhaps this reopening of the discussion will be the means of causing others residing in favoured localities, and having eyes a little keener than the average, to add further testimony when the next conjunction takes place.

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The objects of the Society, incorporated in 1890, are:

(*a*) "To study Astronomy, Astrophysics and such cognate subjects as shall be approved of by the Society and as shall, in its opinion, tend to the better consideration and elucidation of Astronomical and Astrophysical problems; and to diffuse theoretical and practical knowledge with respect to such subjects.

(*b*) To publish from time to time the results of the work of the Society; and,

(*c*) To acquire and maintain a Library, and such apparatus and real and personal property as may be necessary and convenient for the carrying into effect of the objects of the Society."

For many years the Toronto organization existed alone, but now the Society is national in extent, having active Centres in Montreal, P.Q.; Ottawa, Ont.; Toronto, Ont.; London, Ont.; Winnipeg, Man.; and Victoria, B.C. Among its 800 members are a number of the leading astronomers and scientists of the world, many amateurs, and in addition, many laymen who are interested in the culture of the science.

Membership in the Society is open to anyone interested in Astronomy. The annual dues are $2.00; life membership $25.00 (no further dues). The annual fee includes subscription to the publications.

The Society publishes a monthly JOURNAL containing about 400 pages of interesting articles, and the yearly HANDBOOK of 72 pages containing valuable information for the amateur observer. Single copies of the JOURNAL or HANDBOOK are 25 cents.

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